Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 16 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WBI12/01**

Biology

International Advanced Subsidiary/Advanced Level
UNIT 2: Cells, Development, Biodiversity and Conservation

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The photograph shows a grasshopper being caught in a web by a wasp spider.



(Source: © Nicola Ferrari / Alamy Stock Photo)

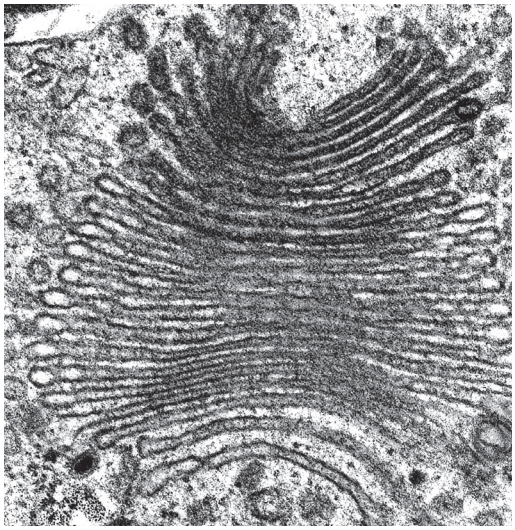
The spider uses extracellular enzymes from its digestive system to digest parts of the grasshopper.

(a) The digestive system is an organ system.

State what is meant by the term **organ system**.

(1)

(b) The photograph shows an organelle involved in the formation of extracellular enzymes, as seen using an electron microscope.



(Source: © Science Photo Library)

(i) Name organelle A, shown in the photograph.

(1)

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(ii) Describe the role of **this** organelle in the formation and transport of extracellular enzymes.

(2)

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(iii) A student measured the width of one part of the organelle in the photograph as 3.2 cm.

The actual width was 0.95 μm.

Calculate the magnification of the photograph.

Give your answer to **two** significant figures.

(2)

× .....

(Total for Question 1 = 6 marks)

2 Woese classified organisms into a three-domain system.

(a) Which domains contain prokaryotic organisms?

1. Archaea
2. Bacteria
3. Eukarya

(1)

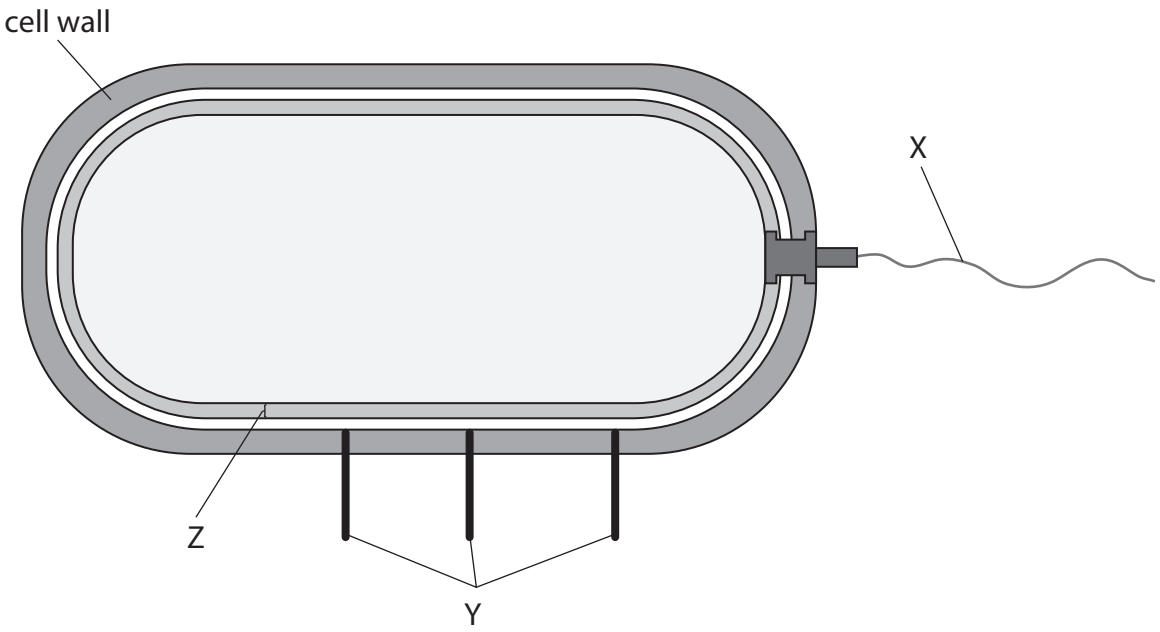
☒ **A** 1 and 2 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

(b) The diagram shows part of a prokaryotic cell.



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(i) Which row gives the name and function of structure Z?

(1)

		Name	Function
☒	**A**	capsule	adhesion to surfaces
☒	**B**	capsule	prevent water loss
☒	**C**	cell membrane	protein synthesis
☒	**D**	cell membrane	controls what enters and leaves the cell

(ii) Give the name and function of structure X and structure Y.

(2)

Name of structure X

.....

Function

.....

.....

.....

Name of structure Y

.....

Function

.....

.....

.....

(iii) Which structure could be found inside a **prokaryotic** cell?

(1)

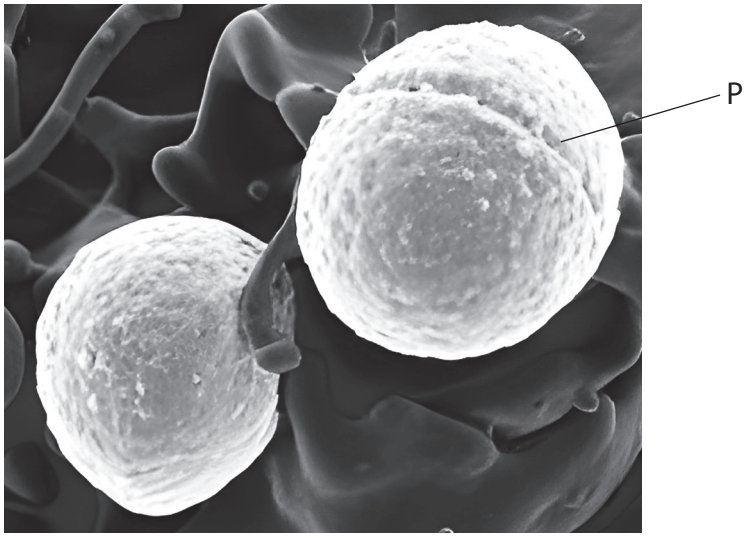
☒ **A** chloroplast

☒ **B** linear DNA

☒ **C** nucleolus

☒ **D** ribosome

(c) The photograph shows two prokaryotic cells, as seen using an electron microscope.



(Source: © BSIP SA / Alamy Stock Photo)

(i) The electron microscope had a resolution of 2 nm.

State what is meant by the term **resolution**.

(1)

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(ii) The cell labelled P has a diameter of 0.60 μm.

Calculate the volume of cell P.

Use the formula:

$$V = \frac{4}{3}\pi r^3$$

Give your answer to **two** decimal places.

(2)

Answer ..... μm^3

(Total for Question 2 = 8 marks)

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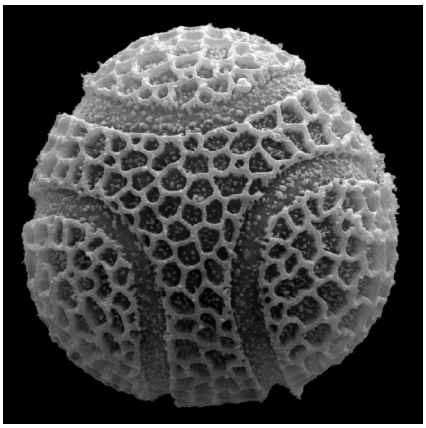
3 The photograph shows a pollen grain from a passion flower.



(Source: © Power and Syred / Science Photo Library)

(a) Pollen grains contain a generative nucleus.

The generative nucleus divides to form two male nuclei.

Which statement is correct?

(1)

☒ **A** one male nucleus is involved in the formation of the pollen tube

☒ **B** one male nucleus is needed to fertilise an egg cell nucleus to form the embryo

☒ **C** the male nuclei are diploid

☒ **D** two male nuclei are needed to fertilise a polar nucleus to form the endosperm

(b) There is genetic diversity in the passion flower population.

Two causes of genetic diversity in this population are mutations and crossing over of non-sister chromatids on homologous chromosomes.

(i) Name the stage of meiosis when crossing over of chromatids occurs.

(1)

(ii) Describe **two** other processes that can give rise to genetic variation in the offspring of the passion flower.

(2)

1 .....

.....

.....

2 .....

.....

.....

(iii) The heterozygosity index is a way of measuring the genetic diversity in a population.

Write an equation for the heterozygosity index.

(1)

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(c) Seeds from plant species are stored in seed banks.

Explain how seeds would be selected for storage in a seed bank.

(2)

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(Total for Question 3 = 7 marks)

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QUESTION 4 BEGINS ON THE NEXT PAGE

4 Parts of a bamboo plant are useful building materials due to their high tensile strength.

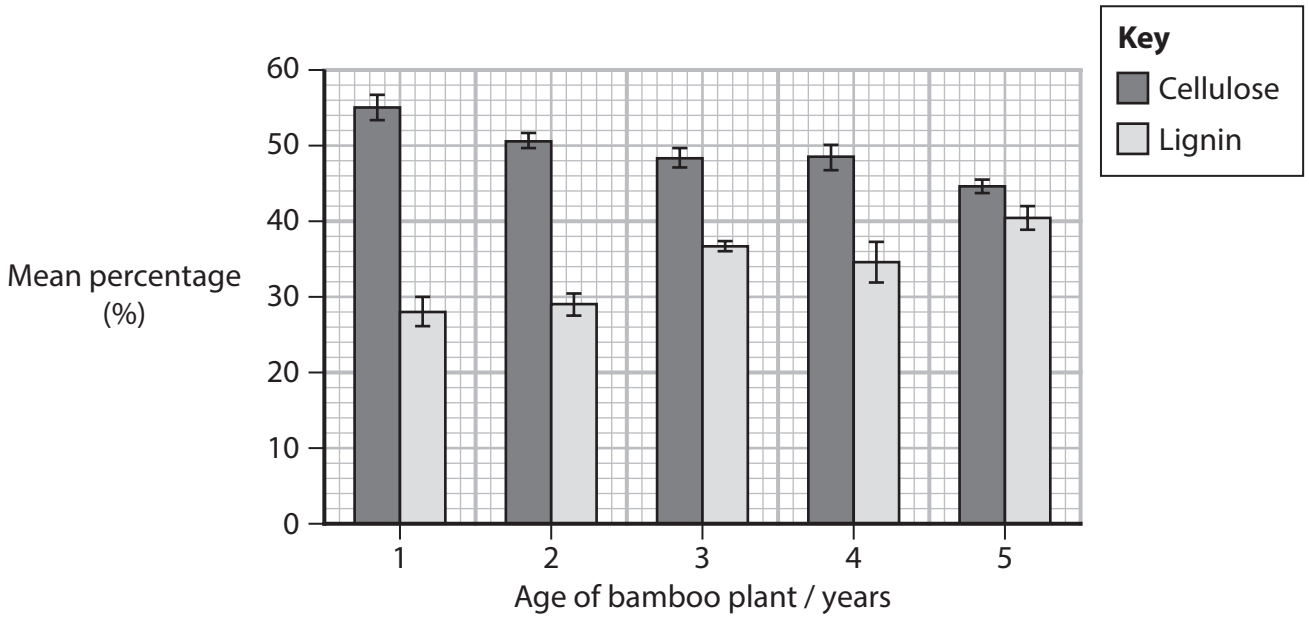
The photograph shows a bridge in Cambodia that has been made from parts of bamboo plants.



(Source: © Bjorn Svensson / Science Photo Library)

(a) Cellulose and lignin contribute to the high tensile strength of bamboo.

The graph shows the mean percentage of cellulose and lignin in bamboo plants of different ages.



(Source: adapted from https://www.mdpi.com/2073-4360/12/1/187)

(i) Calculate the ratio of cellulose to lignin for a one-year-old bamboo plant.

(1)

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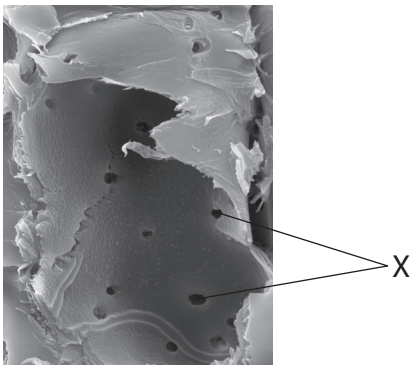
(ii) Give **one** conclusion that can be made about the effect of age on the mean percentage of **both cellulose and lignin** content of bamboo plants.

(1)

(iii) Explain how the arrangement of molecules in the cell walls of xylem contributes to the high tensile strength of the bamboo plant.

(3)

(b) The photograph shows part of the plant cell wall from a bamboo plant.



(Source: © Eye of Science / Science Photo Library)

Which are the structures labelled X?

(1)

- ☒ **A** amyloplasts
- ☒ **B** chloroplasts
- ☒ **C** plasmodesmata
- ☒ **D** tonoplasts

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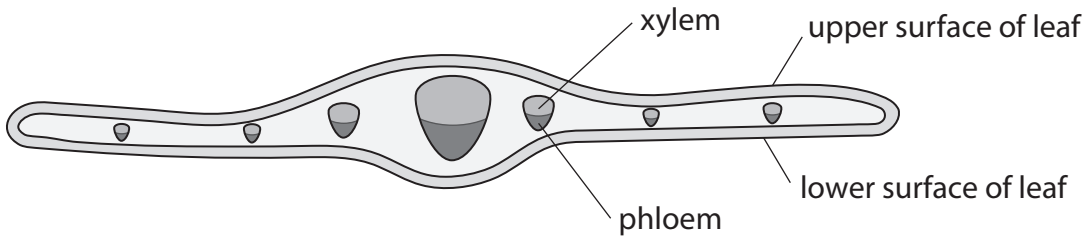
(c) The diagram shows the arrangement of xylem and phloem in a transverse section of a plant leaf.



(i) Which of the following are functions of xylem vessels?

1. give support to the plant
2. translocation of organic solutes to the leaves
3. transport of inorganic ions to the leaves
4. transport of water molecules to the leaves

(1)

☒ **A** 1, 2 and 3 only

☒ **B** 1, 3 and 4 only

☒ **C** 1 and 3 only

☒ **D** 1 and 4 only

(ii) Give **one** difference between the distribution of phloem and xylem in the leaf compared with their distribution in a transverse section of a stem.

(1)

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(Total for Question 4 = 8 marks)

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5 Many useful products can be made from plants.

(a) The photograph shows a drinking cup.



(Source: © Alex Hinds / Alamy Stock Photo)

This cup is made from parts of a sugarcane plant that are left over from commercial production of sugar.

Explain why **this** cup would be considered a sustainable product.

(2)

(b) Substances derived from plants can have antimicrobial properties.

The antimicrobial properties of an extract made from olive oil were investigated.

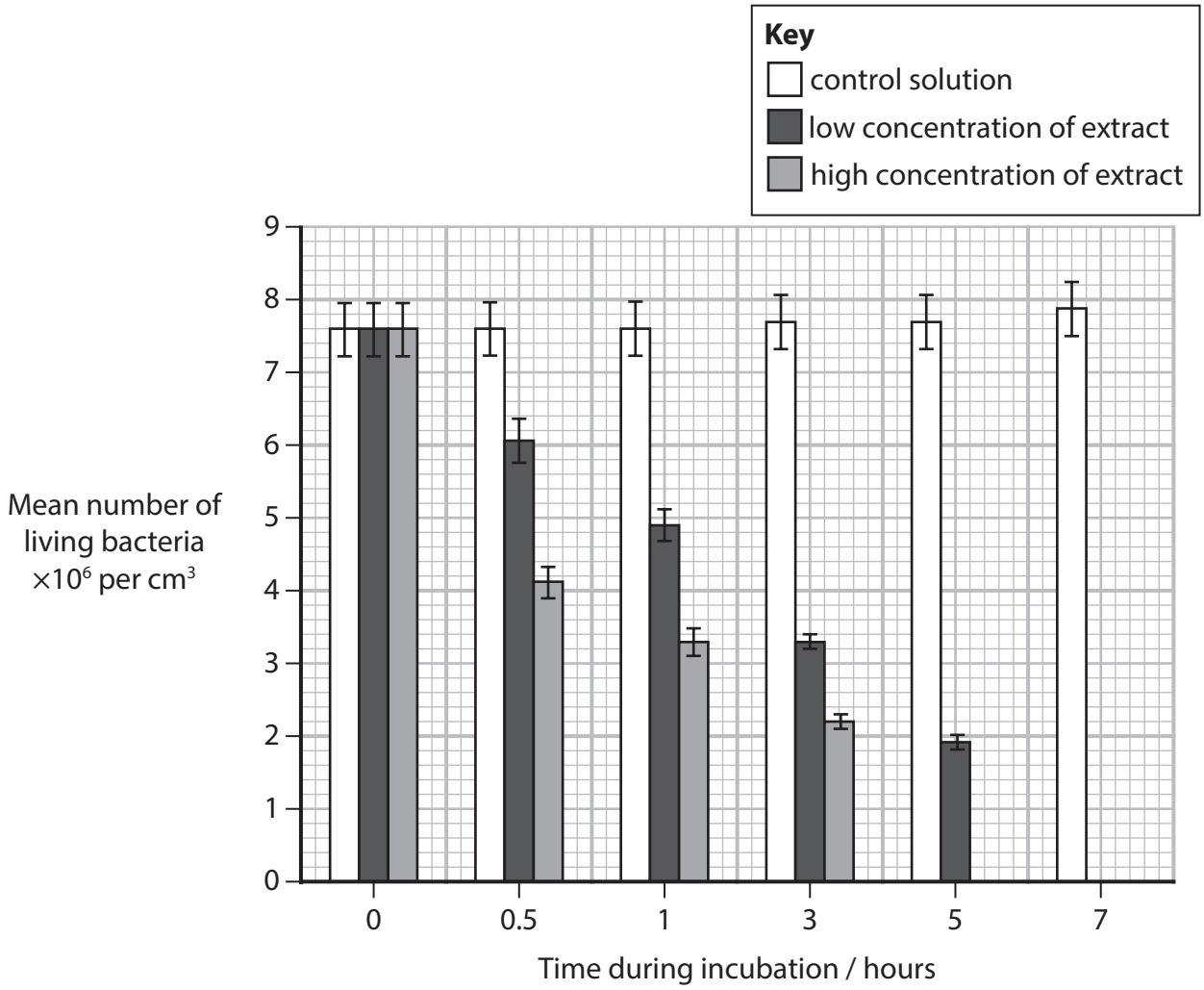
The same number of bacteria were added to tubes containing the same volume of one of the following:

- control solution
- low concentration of extract
- high concentration of extract.

A sample of bacteria was taken from each tube during incubation.

The mean number of living bacteria was determined.

The graph shows the results of this investigation.



(Source: adapted from https://www.frontiersin.org/articles/10.3389/fmicb.2019.01586/full)

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Comment on the results of this investigation.

(4)

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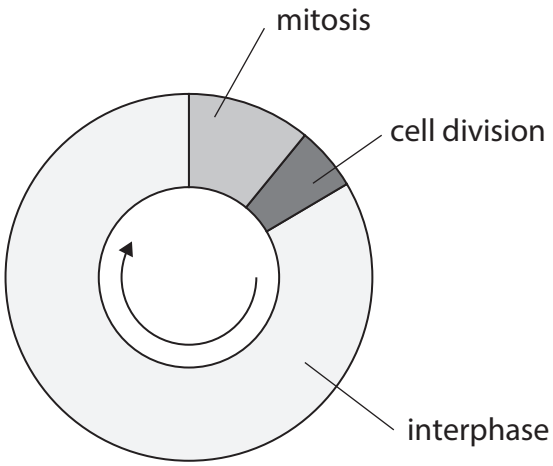
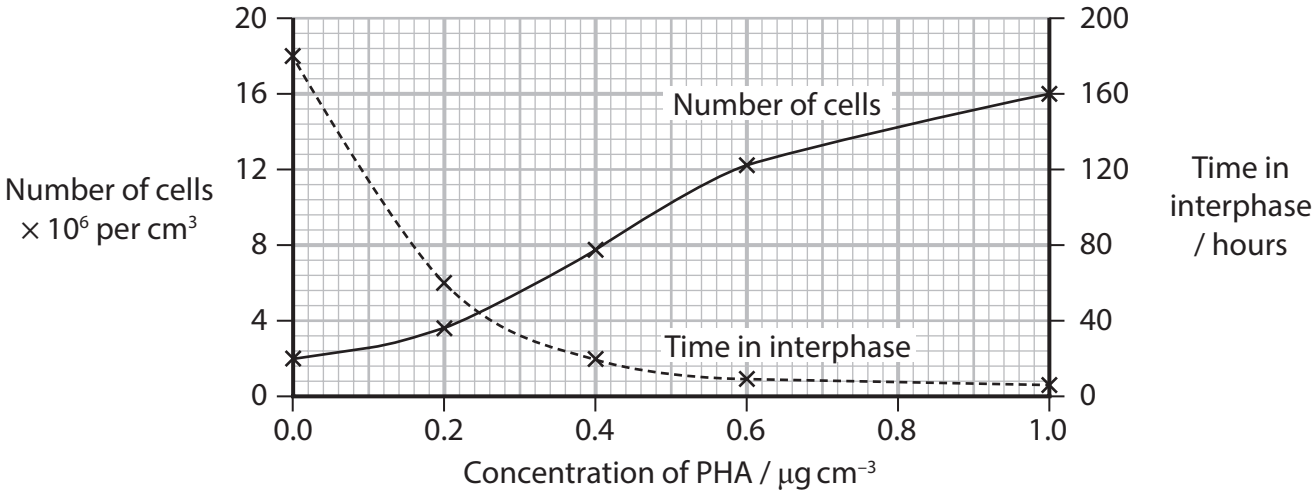
(c) Phytohemagglutinin (PHA) is a type of molecule that can be extracted from the common bean.

This molecule has an effect on the interphase stage of the cell cycle shown in the diagram.



In an investigation, white blood cells were treated with different concentrations of PHA.

The graph shows the effect of this treatment on the number of white blood cells and the length of time they were in interphase.



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(i) State the relationship between the time in interphase and the number of cells.

(1)

(ii) Which is the correct percentage change in cell number from 0.0 to 1.0 $\mu g\,cm^{-3}$ of PHA?

(1)

☒ **A** –700 %

☒ **B** –87.5 %

☒ **C** +87.5 %

☒ **D** +700 %

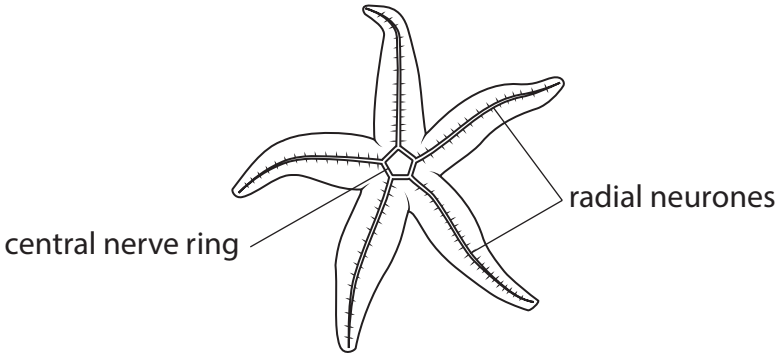
(iii) Explain the results of this investigation.

(3)

(Total for Question 5 = 11 marks)

6 Multicellular organisms, like starfish, contain many different types of cells.

(a) The diagram shows part of the nervous system of a starfish.



(Source: adapted from https://royalsocietypublishing.org/doi/pdf/10.1098/rstb.1950.0010)

(i) When nerve cells are damaged in this starfish, the gene sox2 is activated. Suggest how cell damage could lead to activation of this gene.

(2)

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(ii) Activation of the sox2 gene can stimulate body cells to become pluripotent stem cells.

Give **one** difference between a **pluripotent** stem cell and a **totipotent** stem cell.

(1)

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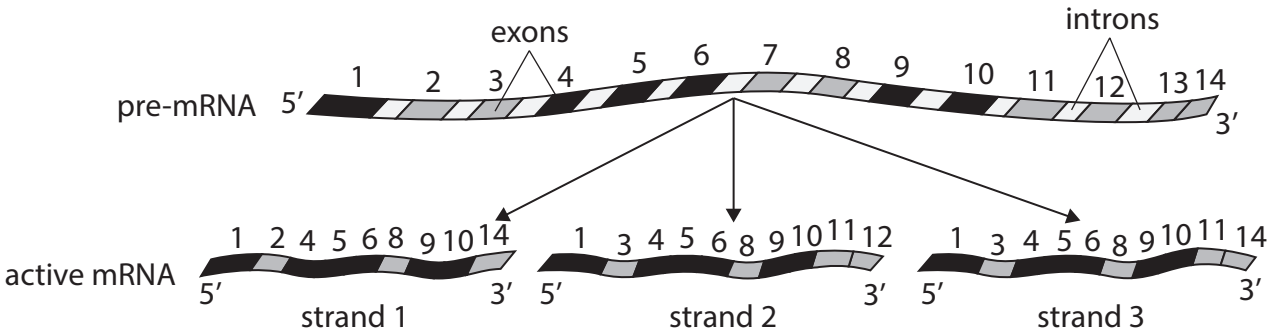
(b) One gene from this starfish pluripotent stem cell produces pre-mRNA.

The diagram shows how three different strands of active mRNA are produced from one strand of pre-mRNA.



Explain how **these** three active mRNA strands are produced.

Use the diagram to support your answer.

(4)

(c) Society has approved the use of stem cells taken from starfish for research.

Suggest why society has approved the use of these **stem cells**.

(3)

(Total for Question 6 = 10 marks)

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QUESTION 7 BEGINS ON THE NEXT PAGE

7 The photograph shows strawberry plants growing in a hydroponic system.

In these systems, the plants grow in nutrient solutions instead of in soil.



(Source: © Stephanie Jackson - Agriculture / Alamy Stock Photo)

The nutrient solutions contain inorganic ions and water.

(a) (i) Give **two** reasons why water is important to the strawberry plants.

(2)

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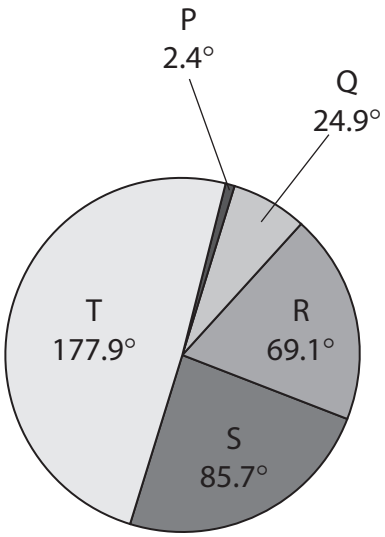
(ii) The nutrient solution contains nitrate ions and calcium ions.

Explain the importance of these ions to the strawberry plants.

(3)

(b) The diagram shows the strawberry production in five continents, P, Q, R, S and T, in 2021.



Continent Q produced 634 288 000 kg of strawberries in 2021.

Which is the mass of strawberries produced in continent S?

(1)

☒ **A** 61 136 193 kg

☒ **B** 760 212 883 kg

☒ **C** 2 183 071 550 kg

☒ **D** 4 531 720 288 kg

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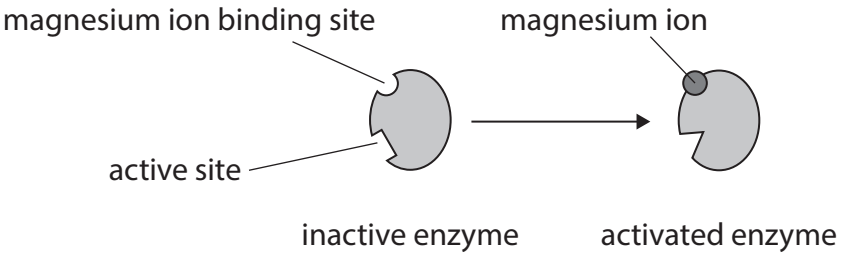
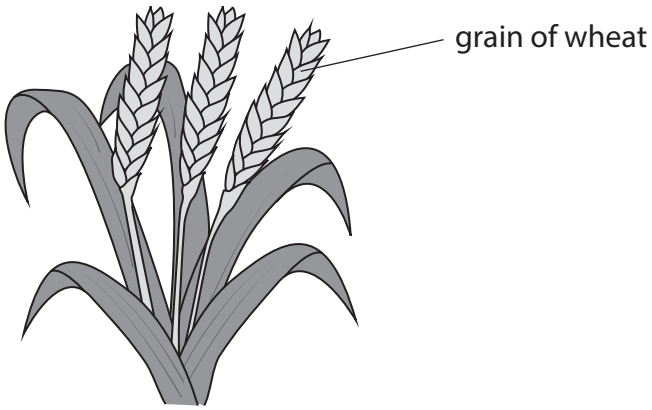
(c) In plants, magnesium ions are needed to activate enzymes required for:

- inorganic ion uptake
- protein synthesis
- photosynthesis.

The diagram shows how the attachment of a magnesium ion activates an enzyme.



The diagram shows grains of wheat on a wheat plant.



Grains of wheat can be ground into flour.

Flour with a higher protein content is generally more expensive.

One protein that is found in the grains of wheat plants is gluten.

The effect of magnesium ions on the mean mass of wheat grains and the mean gluten content of wheat grains was investigated.

Three groups of wheat plants were grown in separate hydroponic systems containing a nutrient solution.

The table shows the different treatments.

Group	Type of nutrient solution	Magnesium ion solution applied to leaves
A	all inorganic ions except magnesium ions	no
B	all inorganic ions except magnesium ions	yes
C	all inorganic ions including magnesium ions	no

The table shows the effect of these treatments on the mean mass of wheat grains per square metre of plants and the mean mass of gluten per kilogram of wheat grains.

Group	Mean mass of wheat grains / kg m^{-2}	Mean mass of gluten in wheat grains / g kg^{-1}
A	0.58	265
B	0.65	283
C	0.67	298

(i) Calculate the percentage difference in the mean mass of wheat grains of the plants in group A and group B.

Use the equation:

$$\text{percentage difference between A and B} = \frac{A - B}{\left(\frac{A + B}{2}\right)} \times 100$$

Give your answer to **an appropriate number of** decimal places.

(2)

Answer ..... %

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*(ii) Farmers concluded that they would make more money if magnesium ions were added to growing wheat plants.

Discuss this conclusion.

Use **all** the information in part (c) to support your answer.

(6)

(Total for Question 7 = 14 marks)

8 An egg cell is a specialised cell.

(a) The acrosome reaction is stimulated when a sperm cell binds to the ZP3 protein on the zona pellucida of an egg cell.

Describe the acrosome reaction.

(3)

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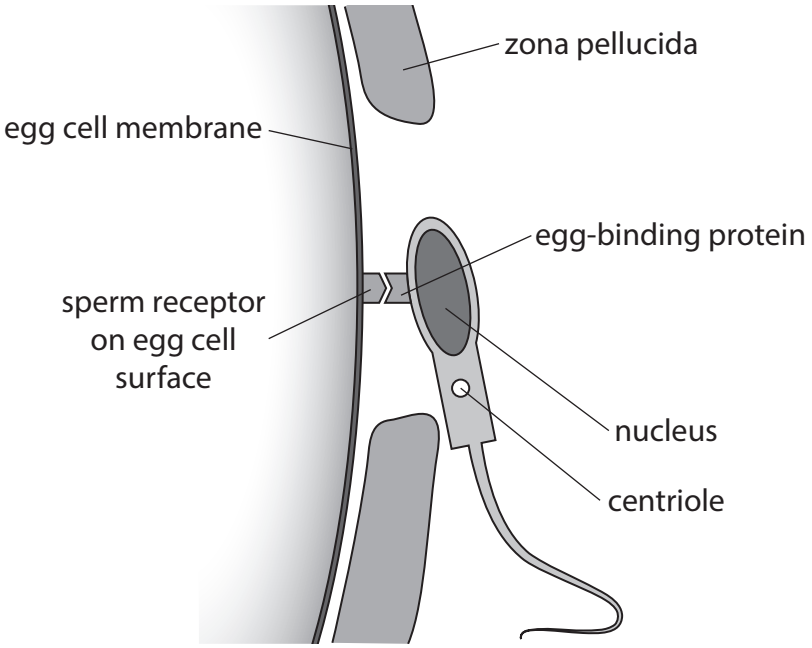
(b) When a sperm cell arrives at an egg cell surface it binds to a receptor on the egg cell surface membrane.

The diagram shows a sperm cell binding to a complementary shaped receptor on the egg cell surface membrane.



(Source: adapted from https://www.sciencedirect.com/topics/nursing-and-health-professions/zona-pellucida-glycoprotein)

(i) Suggest why some sperm cells may not be able to bind to the sperm receptor on the egg cell surface membrane.

(3)

(ii) Explain how more sperm cells are prevented from entering the egg cell.

(2)

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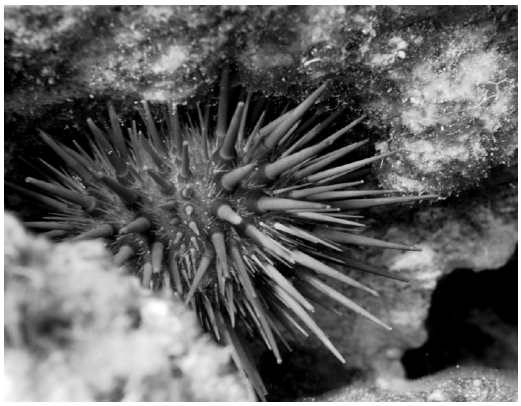
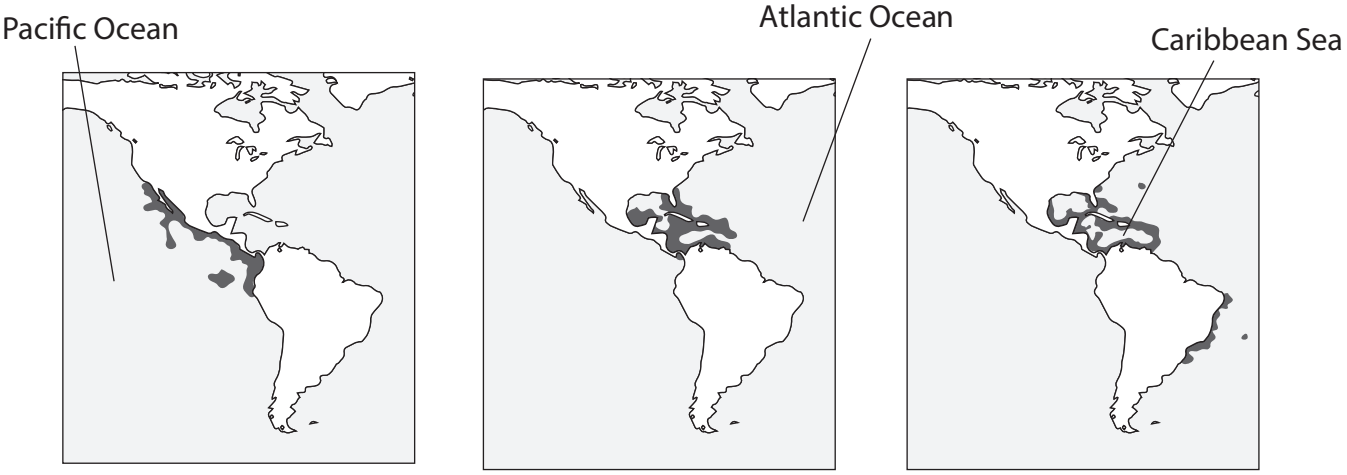
(c) The photograph shows a species of reef urchin (*E. lucunter*) found in the Caribbean Sea.



(Source: © NomisH / Alamy Stock Photo)

Sperm cells from *E. viridis* and *E. vanbrunti* cannot fertilise egg cells of *E. lucunter*. The maps show the distribution of these three species.



distribution of *E. vanbrunti* distribution of *E. viridis* distribution of *E. lucunter*

(Source: adapted from https://www.gbif.org/species/2278861)

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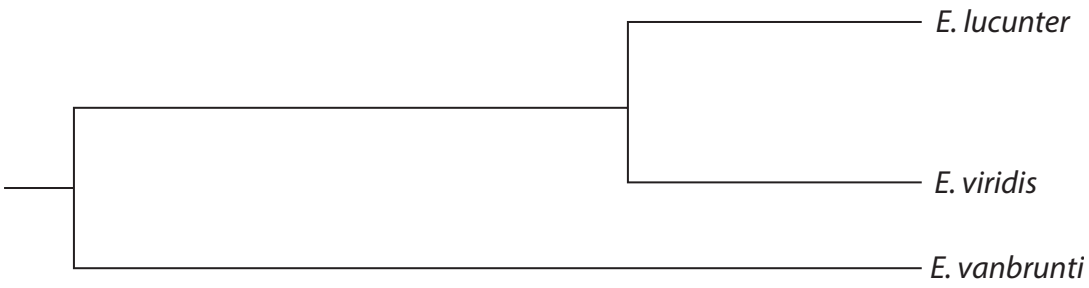
The diagram shows the relationship between these three species.



(i) Explain how scientists could have determined that *E. viridis* was more closely related to *E. lucunter* than to *E. vanbrunti*.

(2)

*(ii) Explain how reproductive isolation could have led to the formation of these three species.

Use your own knowledge and **all** the information from question 8 to support your answer.

(6)

(Total for Question 8 = 16 marks)

TOTAL FOR PAPER = 80 MARKS

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